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Boariu et al.

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(54) **MOBILE STATION AGGREGATION OF ACKNOWLEDGMENTS AND NEGATIVE ACKNOWLEDGMENTS IN WIRELESS NETWORKS**

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CPC ***H04W 72/085*** (2013.01); ***H04L 1/1614*** (2013.01); ***H04L 1/1825*** (2013.01); *H04W 72/0406* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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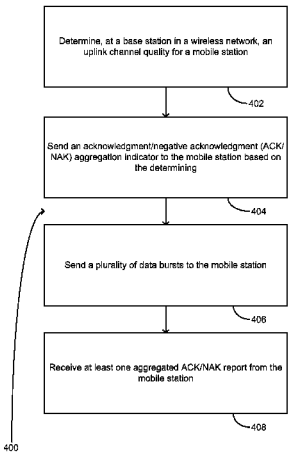
(57) **ABSTRACT**

Various example embodiments are disclosed herein. According to one example embodiment, a method may include determining, at a base station in a wireless network, an uplink channel quality for a mobile station, sending an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station based on the determining, sending a plurality of data bursts to the mobile station, and receiving at least one aggregated ACK/NAK report from the mobile station.

21 Claims, 6 Drawing Sheets



(51) **Int. Cl.**
H04L 1/18 (2006.01)
H04W 72/04 (2009.01)

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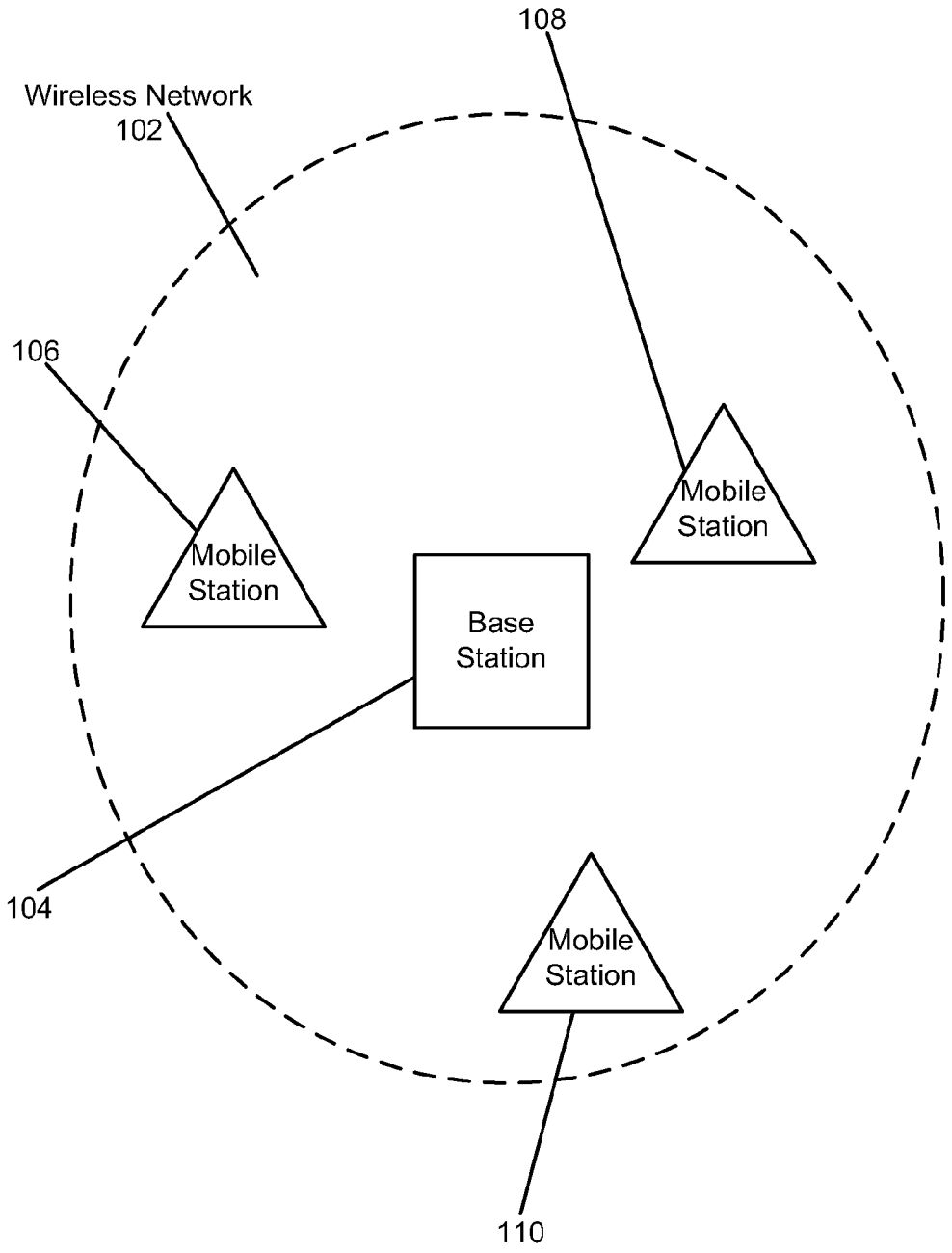
108
Wireless Network
102
106
Mobile Station
Mobile Station
Base Station
104
Mobile Station
110

FIG. 1

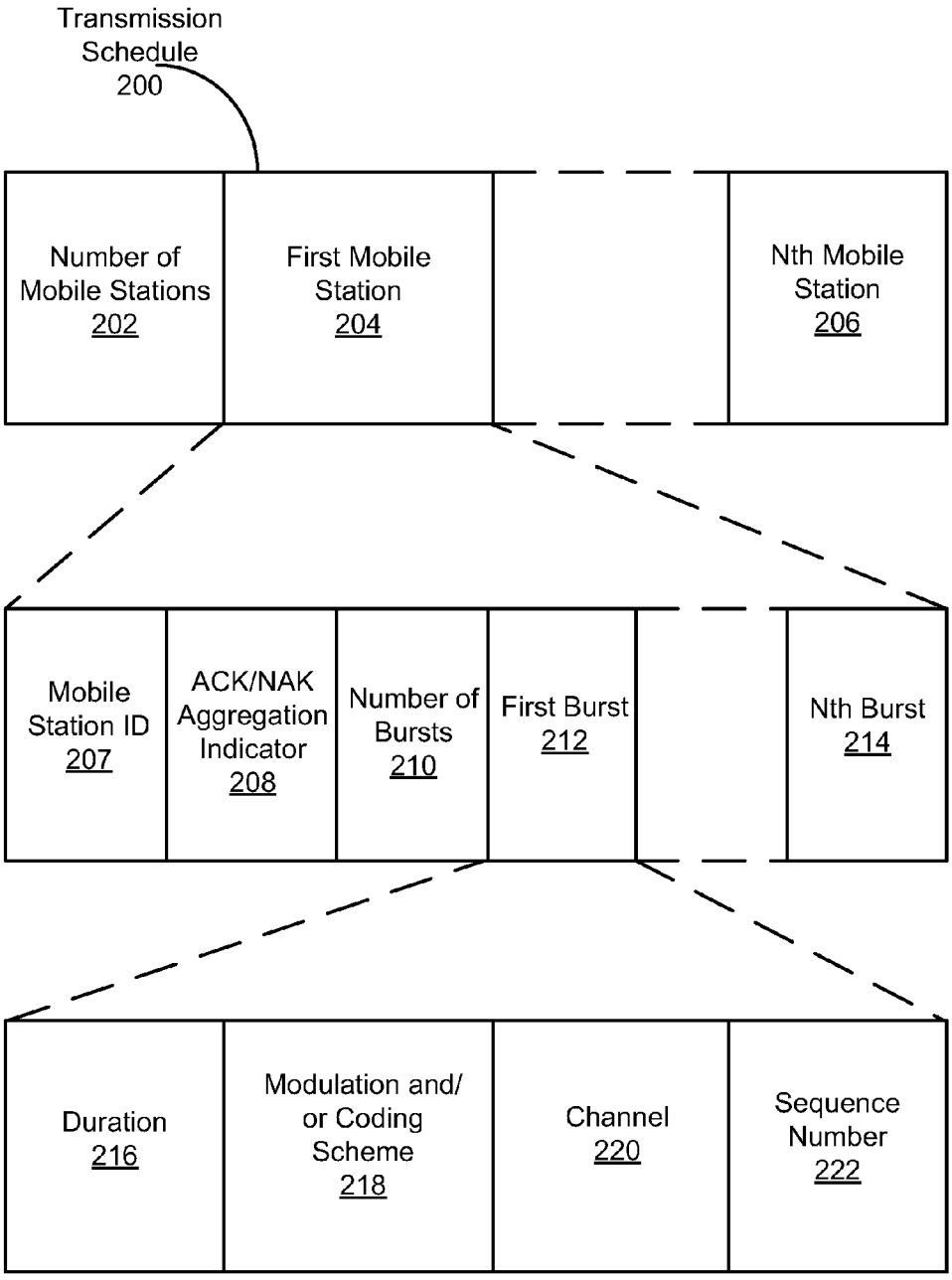
Transmission Schedule 200
Number of Mobile Stations 202
First Mobile Station 204
Nth Mobile Station 206
Mobile Station ID 207
ACK/NAK Aggregation Indicator 208
Number of Bursts 210
First Burst 212
Nth Burst 214
Duration 216
Modulation and/or Coding Scheme 218
Channel 220
Sequence Number 222

FIG. 2

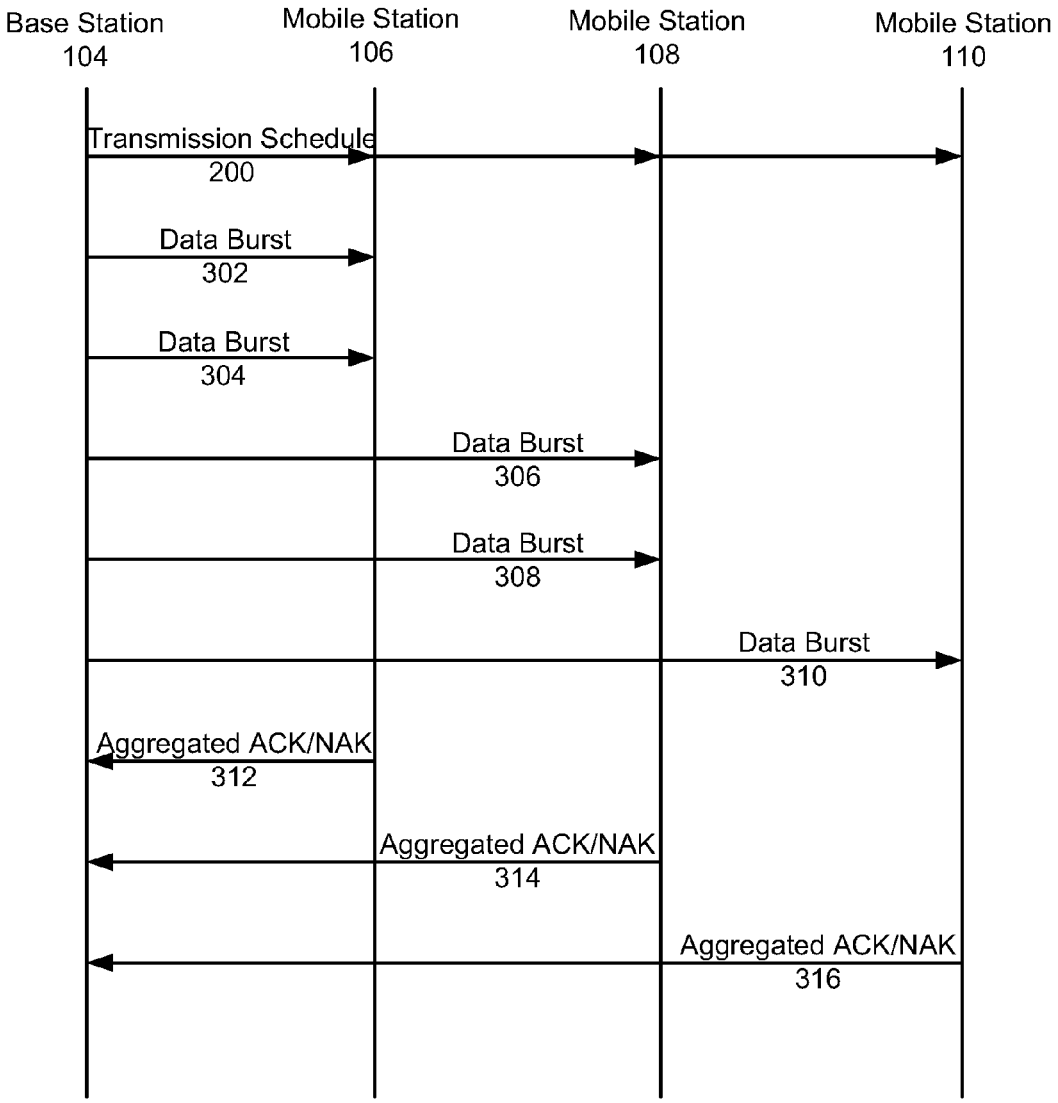
Base Station
104
Mobile Station
106
Mobile Station
108
Mobile Station
110
Transmission Schedule
200
Data Burst
302
Data Burst
304
Data Burst
306
Data Burst
308
Data Burst
310
Aggregated ACK/NAK
312
Aggregated ACK/NAK
314
Aggregated ACK/NAK
316

FIG. 3

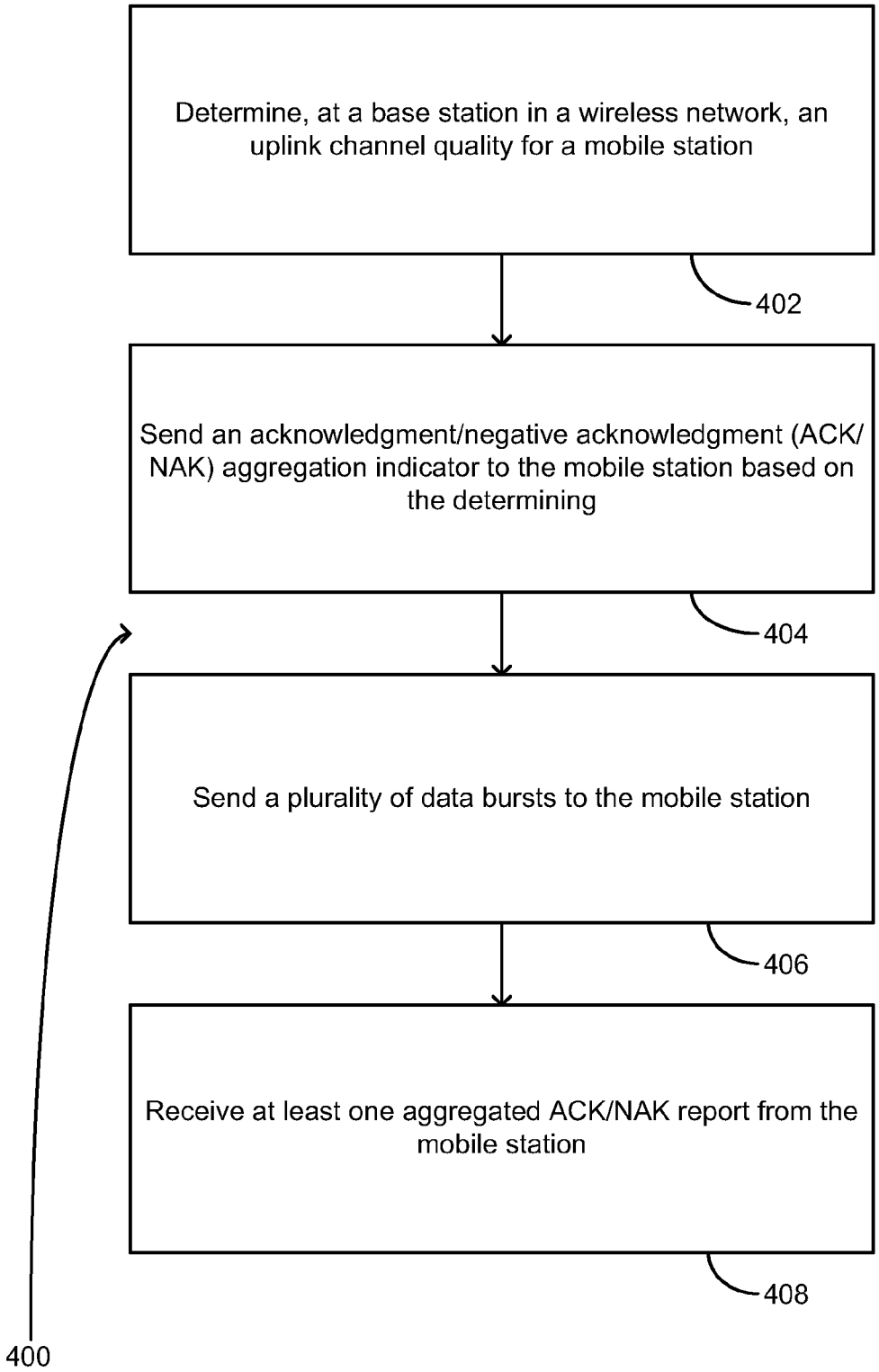
Determine, at a base station in a wireless network, an uplink channel quality for a mobile station
402
Send an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station based on the determining
404
Send a plurality of data bursts to the mobile station
406
Receive at least one aggregated ACK/NAK report from the mobile station
408
400

FIG. 4

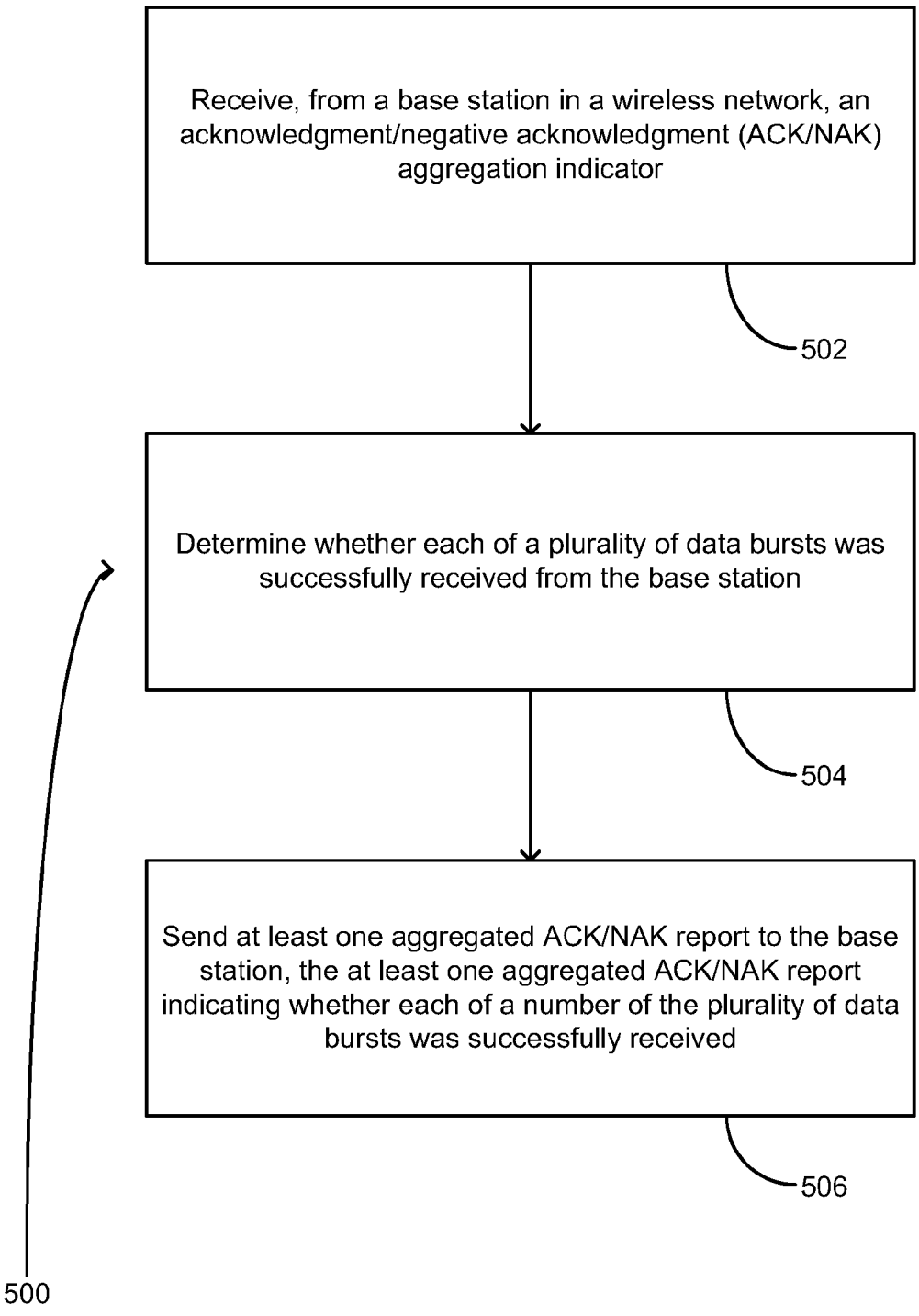
Receive, from a base station in a wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator
502
Determine whether each of a plurality of data bursts was successfully received from the base station
504
Send at least one aggregated ACK/NAK report to the base station, the at least one aggregated ACK/NAK report indicating whether each of a number of the plurality of data bursts was successfully received
506
500

FIG. 5

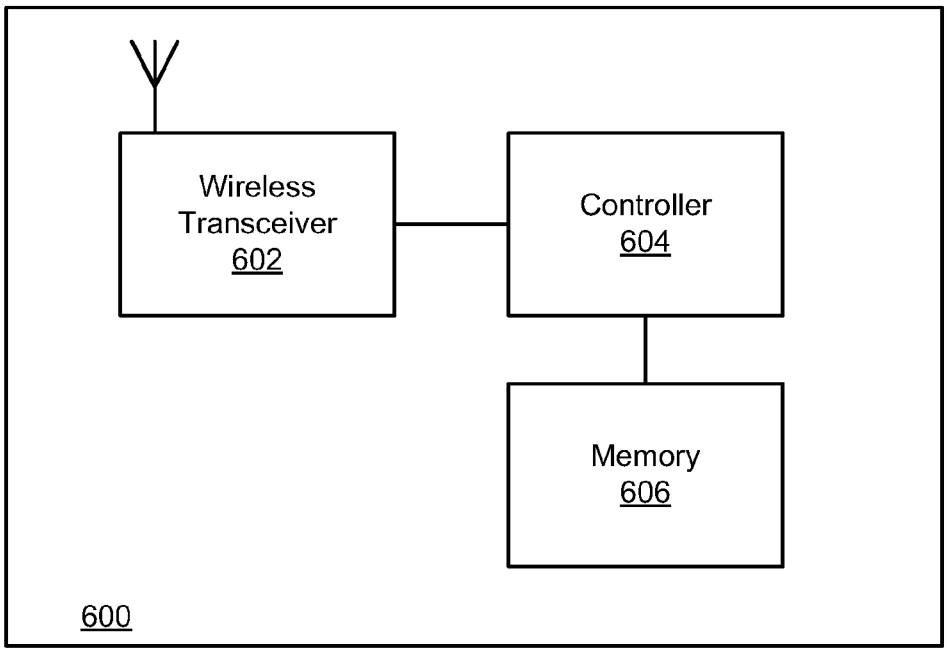

FIG. 6

MOBILE STATION AGGREGATION OF ACKNOWLEDGMENTS AND NEGATIVE ACKNOWLEDGMENTS IN WIRELESS NETWORKS

PRIORITY CLAIM

This application is a National Stage Application of PCT/US2008/071989, filed on Aug. 1, 2008, entitled, "Mobile Station Aggregation of Acknowledgments and Negative Acknowledgments in Wireless Networks," which claims the benefit of priority based on U.S. Provisional Application No. 60/953,867, filed on Aug. 3, 2007, entitled, "Mobile Station Aggregation of Acknowledgments and Negative Acknowledgments in Wireless Networks." This application claims the benefit of both PCT/US2008/071989, filed on Aug. 1, 2008 and U.S. Provisional Application No. 60/953,867, filed on Aug. 3, 2007, the disclosures of both of which are hereby incorporated by reference.

TECHNICAL FIELD

This description relates to wireless networks.

BACKGROUND

In wireless networks, a base station may transmit data bursts to one or more mobile stations. The mobile stations may transmit acknowledgments (ACKs) or negative acknowledgments (NAKs) to the base station to indicate whether each of the data bursts were successfully received.

SUMMARY

According to one general aspect, a method may include determining, at a base station in a wireless network, an uplink channel quality for a mobile station, sending an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station based on the determining, sending a plurality of data bursts to the mobile station, and receiving at least one aggregated ACK/NAK report from the mobile station.

According to another general aspect, a method may include receiving, from a base station in a wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, determining whether each of a plurality of data bursts was successfully received from the base station, and sending at least one aggregated ACK/NAK report to the base station. The at least one aggregated ACK/NAK report may indicate whether each of a number of the plurality of data bursts was successfully received. A number of ACK/NAKs aggregated into the at least one aggregated ACK/NAK report may be based on the ACK/NAK aggregation indicator.

According to another general aspect, an apparatus may include a controller. The apparatus may be configured to determine, at a base station in a wireless network, an uplink channel quality for a mobile station, to send an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station based on the determining, to send a plurality of data bursts to the mobile station, and to receive at least one aggregated ACK/NAK report from the mobile station.

According to another general aspect, an apparatus may include a controller. The apparatus may be configured to receive, from a base station in a wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, to determine whether each of a plurality of data bursts was successfully received from the base station, and to send at least one aggregated ACK/NAK report to the base station. The at least one aggregated ACK/NAK report may indicate whether each of a number of the plurality of data bursts, for which a corresponding number of ACK/NAKs were aggregated into the at least one aggregated ACK/NAK report, was successfully received.

According to another general aspect, a computer readable storage medium may comprise executable code stored thereon that, when executed by a processor, causes an apparatus to at least determine, in a wireless network, an uplink channel quality for a mobile station, send an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station based on the determining, send a plurality of data bursts to the mobile station, and receive at least one aggregated ACK/NAK report from the mobile station.

According to another general aspect, a computer readable storage medium may comprise executable code stored thereon that, when executed by a processor, causes an apparatus to at least receive, from a base station in a wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, determine whether each of a plurality of data bursts was successfully received from the base station, and send at least one aggregated ACK/NAK report to the base station based on the determining, the at least one aggregated ACK/NAK report indicating whether each of a plurality of data bursts, for which a corresponding number of ACK/NAKs were aggregated into the at least one aggregated ACK/NAK report, was successfully received.

The details of one or more implementations are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of wireless network including a base station and a plurality of mobile stations according to an example embodiment.

FIG. **2** is a block diagram of a transmission schedule according to an example embodiment.

FIG. **3** is a vertical-time sequence diagram showing an exchange of transmissions between the base station and the mobile stations according to an example embodiment.

FIG. **4** is a flowchart showing a method according to an example embodiment.

FIG. **5** is a flowchart showing a method according to an example embodiment.

FIG. **6** is a block diagram showing an apparatus according to an example embodiment.

DETAILED DESCRIPTION

FIG. **1** is a block diagram of wireless network **102** including a base station **104** and a plurality of mobile stations **106**, **108**, **110** according to an example embodiment. The wireless network **102** may, for example, include an IEEE 802.11 wireless local area network (WLAN), an IEEE 802.16 wireless local metropolitan area network (WiMAX), or a cellular telephone network. The base station **104** may include a WiMAX base station, cellular base station, node B, or WLAN access point, according to example embodiments. The mobile stations **106**, **108**, **110** may include laptop computers, personal digital assistants (PDAs), smartphones, cellular telephones, or relay stations according to example embodiments. The base station **104** may send information to the mobile stations

106, 108, 110 by transmitting data bursts to one or more of the mobile stations 106, 108, 110. Error control mechanisms may be used to detect and correct errors that occur in the transmission of data bursts to the mobile stations 106, 108, 110. While the present disclosure utilizes the terminology of WiMAX, aspects of the present disclosure may be applicable to other wired or wireless technologies.

According to one hybrid automatic repeat request (HARQ) error control mechanism, the base station 104 may transmit a predetermined number, such as one or more, data bursts to each mobile station 106, 108, 110 over a predetermined time interval. The data bursts may each have been sent along a single channel, which may have been communicated to the mobile stations 106, 108, 110 in advance. For example, the base station 104 may have sent a HARQ map to the mobile stations 106, 108, 110, which may include a transmission schedule of the data bursts including channel information for the data bursts, as well as channel information for acknowledgments (ACKs) or negative acknowledgments (NAKs) to be sent in response to each of the data bursts. The transmission schedule may indicate the predetermined time interval over which the data bursts may be sent, or the predetermined time interval may be calculated based on the transmission schedule. In one example embodiment, each data burst may include a cyclic redundancy code (CRC) which may be used for error correction and/or detection. In another example, each data burst may include a number of data blocks. In this latter example, each data block within the data burst may include a CRC.

After the predetermined time interval has elapsed, the mobile stations 106, 108, 110, may send an ACK or NAK to the base station 104. In the example in which each data burst includes one CRC, the mobile stations 106, 108, 110 may send one ACK or NAK to the base station 104 for each data burst. In the example in which each data burst includes a number of data blocks, each data block including a CRC, the mobile stations 106, 108, 110 may send one ACK or NAK to the base station 104 for each data burst or CRC.

The mobile stations 106, 108, 110 may send the ACK or NAK to the base station 104 after a specified delay period has expired after the sending of the data burst to which the ACK or NAK corresponds. According to this example, each ACK or NAK may be sent to the base station 104 via a single channel. The channel may include a frequency, a time duration, and/or a code. Sending each ACK or NAK via a single channel may be an inefficient use of resources.

In another example embodiment, each mobile station 106, 108, 110 may aggregate some or all of the ACKs or NAKs corresponding to the data bursts scheduled in the HARQ map into aggregated ACK/NAK channels. The number of individual ACK/NAKs that are aggregated into a single aggregated ACK/NAK channel may be determined by the ACK/NAK aggregation indicator, which may be agreed upon between the base station 104 and each individual mobile station 106, 108, 110. This may use the channel resources more efficiently than sending each ACK or NAK via its own channel; however, in some situations, such as where the uplink channel quality is poor, transmission errors in a single channel may cause the loss of a number of ACKs or NAKs, requiring the base station 104 to retransmit all of the data bursts corresponding to the lost ACKs or NAKs.

According to another example embodiment, the ACKs and/or NAKs may be dynamically aggregated based on the uplink channel quality. For example, the base station 104 may determine the uplink channel quality for each mobile station 106, 108, 110. According to one example, three ACKs and/or NAKs may be aggregated when the uplink channel quality is "high," two may be aggregated when the uplink channel quality is "medium," and each ACK or NAK may be sent separately when the uplink channel quality is medium.

The uplink channel quality may be determined, for example, based on a determined distance between the mobile station 106, 108, 110 and the base station 104, based on a received signal strength along an uplink ACK/NAK channel for the mobile station 106, 108, 110 or based on the transmission power of signals sent from the mobile stations 106, 108, 110. The uplink channel quality, such as the determined distance or received signal strength, may be based, for example, on one or more signals received from each mobile station 106, 108, 110. The received signals may, for example, include information such as the transmission strength, which may be based on the mobile station's 106, 108, 110 determination of the distance from the base station 104 or the channel quality. The channel quality may also be determined based on a channel quality indicator received from the mobile station 106, 108, 110, for example.

Based on the determined uplink channel quality, the base station 104 may send to one or more of the mobile stations 106, 108, 110 an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator. The ACK/NAK aggregation indicator may, for example, either be included dynamically in a transmission schedule or HARQ map, or may be included statically/semi-statically by sending a message to one or more of the mobile stations 106, 108, 110. The transmission schedule may, for example, include a MAP (medium access protocol) information element, with information regarding which mobile station(s) will receive data bursts, and how the data bursts should be demodulated and/or decoded.

For example, the ACK/NAK aggregation indicator may be included in an information element for each mobile station 106, 108, 110. One example may include a single information element for each mobile station 106, 108, 110 which will receive data according to the transmission schedule, with each information element including information (such as the ACK/NAK aggregation indicator) applicable to multiple data bursts which will be sent to the mobile station 106, 108, 110. In an example which uses chase combining to combine multiple information elements in a single transmission schedule or downlink HARQ chase burst element, the ACK/NAK aggregation indicator or information element for each mobile station 106, 108, 110 may be included in the single transmission schedule or downlink HARQ chase burst element. The transmission schedule may be included in a frame which also includes one or more of the scheduled data bursts; a transmission schedule with an ACK/NAK aggregation indicator for each mobile station 106, 108, 110 may be included in each frame sent by the base station 104, according to an example embodiment. In another example embodiment, the base station 104 may broadcast the ACK/NAK aggregation indicator to the mobile stations 106, 108, 110 separately from the transmission schedule or HARQ map.

The transmission schedule may, for example, include a schedule of data bursts which will be sent by the base station 104 to each of the mobile stations 106, 108, 110, and may include channel information for each of the data bursts. The ACK/NAK aggregation indicator may indicate a number of data bursts which are to be acknowledged or negatively acknowledged in each ACK channel. This number may be the same or different for each mobile station 106, 108, 110, according to example embodiments. The ACK/NAK aggregation indicator may also, for example, include channel information for the channel(s) via which the aggregated ACK/

NAKs are to be sent. The mobile stations **106**, **108**, **110** may each receive the ACK/NAK aggregation indicator.

The channel via which the aggregated ACK/NAKs are sent may include, for example, an uplink (UL) ACK channel. A full ULACK channel may include three tiles; within each tile, one or more of the specially constructed signals may be transmitted. For example, the number of specially constructed signals can be eight, thus creating an 8-ary codeword alphabet, each codeword (signal) being addressed as an index running from zero to seven. A tile combination vector may include one or more tiles, according to an example embodiment.

Base station **104** may send the ACK/NAK aggregation indicator to one or more of the mobile stations **106**, **108**, **110**. The base station **104** may also send a plurality of data bursts to each of the mobile stations **106**, **108**, **110** (the base station **104** may also send an uplink transmission schedule to the mobile stations **106**, **108**, **110** after sending the transmission schedule which includes the ACK/NAK aggregation indicator and sending the data bursts, and the data bursts sent by the base station **104** may be followed by data bursts sent in the uplink direction from the mobile stations **106**, **108**, **110** to the base station **104**). The data bursts sent by the base station **104** may include MAC (medium access control) packet data units (MPDUs), according to an example embodiment. The data bursts may, for example, have been sent in accordance with the transmission schedule.

The mobile stations **106**, **108**, **110** may determine whether each of the plurality of data bursts scheduled for them were successfully received from the base station **104**. The mobile stations **106**, **108**, **110** may determine whether the data bursts were successfully received by, for example, determining whether the data bursts were received at all via the scheduled channel, by determining whether data included in the data bursts conforms to forward error correction coding or cyclic redundancy coding schemes, or other error detection methods.

The mobile stations **106**, **108**, **110** may each send one or more aggregated ACK/NAK reports to the base station **104**. An aggregated ACK/NAK report may be sent via a single channel, such as an UL ACK channel. The aggregated ACK/NAK reports may each indicate whether a number of data bursts were successfully received or not successfully received based on the determination of whether each of the plurality of data bursts were successfully received. The number of ACKs and/or NAKs in each aggregated ACK/NAK report may be based on the ACK/NAK aggregation indicator. For example, if the ACK/NAK aggregated indicator indicates that mobile station **106** should aggregate three ACKs and/or NAKs into a single channel (such as the UL ACK channel), then each aggregated ACK/NAK report sent by mobile station **106** may include three ACKs and/or NAKs. If the number of data bursts sent or intended to be sent to mobile node **106** is not a multiple of three (or other aggregation number), then the last aggregated ACK/NAK report may include the remainder of the ACKs and/or NAKs to be sent by the mobile station **106** to the base station **104**, according to an example embodiment. According to another example embodiment, an aggregated ACK/NAK report other than the last aggregated ACK/NAK report, such as the first or a middle aggregated ACK/NAK report, may include a remainder of ACKs and/or NAKs.

According to an example embodiment, such as one in which the aggregated ACK/NAK is sent via an UL ACK/NAK channel, the aggregated ACK/NAK may include a tile combination vector. According to one example, the channel via which the aggregated ACK/NAK is transmitted may include three pieces of a 3×3 uplink tile or three pieces of a 4×3 uplink tile. The ACK/NAK bits indicating whether each data burst was successfully received may, for example, be encoded into a length-three codeword over an 8-ary alphabet. In an example embodiment in which three ACKs and/or NAKs are aggregated into each aggregated ACK/NAK, the aggregated ACK/NAKs may be encoded as shown in the following table in which an ACK is represented by a "1" and a NAK is represented by a "0":

Aggregated ACKs and/or NAKs (3 bit reporting) 1 2 3 (bit position)	Vector Indices per Tile Tile (0), Tile (1), Tile (2)
1 1 1	0 0 0
1 1 0	1 1 1
1 0 1	2 2 2
1 0 0	3 3 3
0 1 1	4 4 4
0 1 0	5 5 5
0 0 1	6 6 6
0 0 0	7 7 7

For example, if the mobile station **106** successfully received all three data bursts, then the mobile station **106** may transmit the three-tile combination vector "000". The base station **104** may, upon processing the tile combination vector "000", determine that all three data bursts were successfully received. If the mobile station **106** successfully received the first two data bursts but not the third data burst, the mobile station **106** may transmit the tile combination vector "111"; upon receipt and processing of this tile combination vector, the base station **104** may determine that the first two but not the third data burst were successfully received, and the base station **104** may retransmit the third data burst that has not been received successful by the mobile station **106**. Similarly, if the mobile station **106** successfully received the second and third data bursts, but not the first data burst, the mobile station **106** may transmit the tile combination vector "444", and the base station **104** may receive this tile combination vector and respond accordingly. While the aggregated ACK/NAK in this example occupied half of an UL channel by using three tiles, other example aggregated ACK/NAK reports may occupy a full UL channel by using six tiles, a third of an UL channel by using two tiles, or a sixth of an UL channel by using one tile.

In another example embodiment, the aggregation of the ACK/NAK reports for data bursts may be achieved by superposition or sharing of an UL channel. The ACK/NAK reports may be aggregated into a single shared UL channel using orthogonal codewords for each of the aggregated ACK/NAK reports. For each ACK/NAK report associated with a data burst in the aggregated report, there may be associated a pair of codewords, one for ACK reporting and another for NAK reporting, as is shown in the following table:

ACKs and NAKs assignments for superimposed signal reporting	Vector Indices per Tile Tile (0), Tile (1), Tile (2)
ACK for 1st burst in the aggregation	0 0 0
NAK for 1st burst in the aggregation	1 1 1
ACK for 2nd burst in the aggregation	2 2 2
NAK for 2nd burst in the aggregation	3 3 3
ACK for 3rd burst in the aggregation	4 4 4
NAK for 3rd burst in the aggregation	5 5 5
ACK for 4th burst in the aggregation	6 6 6
NAK for 4th burst in the aggregation	7 7 7

In this example, four ACK/NAK reports may be aggregated by superposition on the same aggregated ACK/NAK report

channel. For example, if the base station **104** transmits four bursts to mobile station **106**, and the first and fourth burst have not been successfully received, then the mobile station **106** may transmit on the aggregated ACK/NAK report channel the superposition of the tile combinations "111" (for the 1st NAK), "222" (for the 2nd ACK), "444" (for the 3rd ACK) and "777" (for the 4th NAK). The superimposed signal of the tile combinations "111"+"222"+"444"+"777" may be decoded by the base station **104** which determines the reception status of each individual burst. The transmission of four superimposed signals may utilize more energy than transmitting one signal. For better detection and channel estimation and based on available power at the mobile stations **106**, **108**, **110**, the base station **104** may configure each mobile station **106**, **108**, **110** to aggregate a number selected from a range of numbers, such as either two, three, or four ACK/NAK reports, per aggregate ACK channel.

The tile combination vector sent via the channel may be orthogonally modulated with quadrature phase-shift keying (QPSK) symbols, for example. The tiles or vector indices, which make up the 8-ary alphabet, may each be represented by eight QPSK symbols, such as by the orthogonal modulation index shown in the following table. In the following table, the vector index shown in the left-hand column corresponds to one of the three vector indices shown in the right-hand column of the previous table:

Vector index	QPSK symbols (codewords)
0	P0, P1, P2, P3, P0, P1, P2, P3
1	P0, P3, P2, P1, P0, P3, P2, P1
2	P0, P0, P1, P1, P2, P2, P3, P3
3	P0, P0, P3, P3, P2, P2, P1, P1
4	P0, P0, P0, P0, P0, P0, P0, P0
5	P0, P2, P0, P2, P0, P2, P0, P2
6	P0, P2, P0, P2, P2, P0, P2, P0
7	P0, P2, P2, P0, P2, P0, P0, P2

For example, the codeword identified as vector index "0" may be represented by the eight QPSK symbols "P0, P1, P2, P3, P0, P1, P2, P3". In an example embodiment, P0 may correspond to a forty-five degree phase shift, P1 may correspond to a one-hundred and thirty-five degree phase shift, P2 may correspond to a negative forty-five degree phase shift, and P3 may correspond to a negative one-hundred and thirty-five degree phase shift.

According to another example embodiment, the vector indices may be represented by codewords shown in the following table:

Vector index	QPSK symbols (codewords)
0	P0, P0, P0, P0, P0, P0, P0, P0
1	P2, P2, P2, P2, P2, P2, P2, P2
2	P1, P1, P1, P1, P1, P1, P1, P1
3	P3, P3, P3, P3, P3, P3, P3, P3
4	P0, P1, P2, P3, P0, P1, P2, P3
5	P2, P3, P0, P1, P2, P3, P0, P1
6	P1, P2, P3, P0, P1, P2, P3, P0
7	P3, P0, P1, P2, P3, P0, P1, P2

In this example, the codeword identified as vector index "0" may be represented by the eight "P0" QPSK symbols.

FIG. **2** is a block diagram of a transmission schedule **200** according to an example embodiment. This figure schematically presents some of the fields included in MAPs that may be used for data scheduling, without showing the actual allocation of data bursts. The transmission schedule **200** may include, for example, a downlink (DL) HARQ Chase burst information element (IE), or a DL HARQ Chase sub-burst IE. The transmission schedule **200** may be sent by the base station **104** to the mobile stations **106**, **108**, **110**. The transmission schedule **200** may indicate how many mobile stations **106**, **108**, **110** a flow of data bursts may be directed to, how many data bursts each mobile station **106**, **108**, **110** may receive, how the mobile stations **106**, **108**, **110** should aggregate their ACKs and/or NAKs, and may provide information about each data burst in the flow.

The transmission schedule **200** may include a number of mobile stations field **202**, according to an example embodiment. The number of mobile stations field **202** may indicate the number of mobile stations **106**, **108**, **110** to which data bursts will be sent during the flow. The transmission schedule **200** may also include fields for each mobile station **106**, **108**, **110**, such as a first mobile station field **204** through an Nth mobile station field **206**; 'N' may correspond to the number of mobile stations **106**, **108**, **110** indicated in the number of mobile stations field **202**.

Each mobile station field, such as the first mobile station field **204**, may include subfields. The mobile station field may include a mobile station ID field **207**, which may identify one of the mobile stations **106**, **108**, **110**, for example. The mobile station field may also include an ACK/NAK aggregation indicator **208**, according to an example embodiment. The ACK/NAK aggregation indicator **208** may indicate a number of ACKs and/or NAKs for data bursts which should be aggregated into each channel (which may be an UL ACK channel). The ACK/NAK aggregation indicator **208** may be updated by the base station **104** for each transmission schedule **200**. For example, the base station **104** may determine the number of ACKs and/or NAKs which should be aggregated based on the uplink channel quality before sending each transmission schedule **200**. The ACK/NAK aggregation indicator **208** may have a range of possible values, such as between one and three. For example, the base station **104** may send a transmission schedule indicating that a given mobile node **106** should aggregate three ACKs and/or NAKs if the uplink channel quality is high, two ACKs and/or NAKs if the uplink channel quality is medium, and only one (i.e., no aggregation) if the uplink channel quality is low. Updating the ACK/NAK aggregation indicator **208** dynamically, such as with each transmission schedule **200**, or periodically, after every 'n' transmission schedules **200**, may allow the base station **104** to vary the mobile stations' **106**, **108**, **110** aggregation of ACKs and/or NAKs based on varying uplink channel conditions.

Each mobile station field, such as the first mobile station field **204**, may include a number of bursts subfield **210**. The number of bursts field **210** may indicate the number of data bursts which will be sent to the given mobile station **204** during the flow.

Each mobile station field, such as the first mobile station field **204**, may also include a number of data burst subfields corresponding to the number of data bursts indicated in the number of bursts subfield **210**. For example, the first mobile station field **204** may include a first burst subfield **212** through an Nth burst subfield **214**, with 'N' corresponding to the number of data bursts indicated in the number of bursts subfield **210**.

Each burst subfield, such as the first burst subfield **212**, may include additional subfields. For example, the first burst subfield **212** may include a duration subfield **216**. The duration subfield **216** may indicate a duration of the data burst, such as in time slots, according to an example embodiment. According to another example embodiment, the duration subfield

216 may indicate the channel resources allocated to the data burst, such as bandwidth and/or time.

The first burst subfield **212** may also include a modulation and/or coding scheme subfield **218**. The modulation and/or coding scheme subfield **218** may indicate a modulation scheme and/or a coding scheme which the base station **104** may use to transmit the data burst to the mobile station **106**. The mobile station **106** may use the information in the modulation and/or coding scheme subfield **218** to demodulate and/or decode the data burst. The first burst subfield **212** may also include a channel subfield **220**, which may indicate a channel via which the data burst may be sent. The mobile station **106** may have access to multiple, such as sixteen, logical channels, and the channel subfield **220** may identify the channel via which the data burst may be transmitted. The first burst subfield **212** may also include a sequence number subfield **222**, which may indicate a sequence number for the data burst. The indicated sequence number may be included in the data burst, and may be used to distinguish the data burst from other data bursts. In an example embodiment, the sequence number includes one bit. Other burst subfields may include subfields corresponding to those described with reference to the first burst subfield **212**.

According to an example embodiment, the following syntax may be used to generate the transmission schedule:

Syntax	Size	Notes
DL HARQ Chase burst IE ( ) {	—	—
N_CID	4 bits	Number of CIDs (mobile stations)
For (I = 0; I < N_CID; I++) {	—	—
RCID_IE ( )	Variable	Identity of mobile station
Nagg	2 bit	00 = 1 ACK/NAK per UL ACK channel 01 = 2 ACKs/NAKs per UL ACK channel 10 = 3 ACKs/NAKs per UL ACK channel 11 = Reserved
N_burst	4 bits	Number of data bursts
For (j = 0; j < N_burst; j++) {	—	—
Duration	10 bits	Duration of data burst in slots
Burst DIUC indicator	1 bit	If Burst DIUC Indicator is 1, this may indicate that DIUC is explicitly assigned for this burst. Otherwise, this burst may use the same DIUC as the previous data burst. If j is 0, then this indicator may be 1.
Reserved	1 bit	
If (burst DIUC indicator == 1) {	—	—
DIUC	4 bits	—
Repetition coding indication	2 bits	0b00 - No repetition coding 0b01 - Repetition coding of 2 used 0b10 - Repetition coding of 4 used 0b11 - Repetition coding of 6 used
}		
ACID	4 bits	
AI_SN	1 bit	
}		
}		
}		

FIG. **3** is a vertical-time sequence diagram showing an exchange of transmissions between the base station **104** and the mobile stations **106**, **108**, **110** according to an example embodiment. In this example, the base station **104** may send the transmission schedule **200** to the three mobile stations **106**, **108**, **110**. The number of mobile stations field **202** may indicate that three mobile stations **106**, **108**, **110** will receive data bursts. For each of the mobile stations **106**, **108**, **110**, the ACK/NAK aggregation indicator subfield **208** for each mobile station **106**, **108**, **110** may indicate that the mobile stations **106**, **108**, **110** may each send an aggregated ACK/NAK report for two data bursts. The number of bursts subfield **210** may indicate that mobile station **106** may receive two data bursts, mobile station **108** may receive two data bursts, and mobile station **110** may receive one data burst.

The mobile stations **106**, **108**, **110** may compute the offset positions or ACK/NAK channels of their respective aggregated ACK/NAK reports based on the transmission schedule, according to an example embodiment. The aggregated ACK/NAK reports may begin after a defined delay period after the last data burst, according to an example embodiment. The first aggregated ACK/NAK report may be considered to be sent in the first offset position or ACK/NAK channel (such as an UL ACK channel), the second aggregated ACK/NAK report in the second offset position or ACK/NAK channel (such as an UL ACK channel), and so on.

The offset positions of the aggregated ACK/NAK reports may be calculated by dividing the number of data bursts to be sent to a given mobile station by the number indicated in the ACK/NAK aggregation indicator **208** and rounding up, according to an example embodiment. In this example, the mobile station **106** may compute that because it will receive two data bursts and will aggregate two ACKs and/or NAKs for two data bursts in the aggregated ACK/NAK report (two divided by two), the mobile station **106** may transmit its aggregated ACK/NAK report in the first offset position or ACK/NAK channel, and the aggregated ACK/NAK report will occupy one ACK/NAK channel. Similarly, the mobile station **108** may compute that because it will receive two data bursts and will aggregate two ACKs and/or NAKs for two data bursts in the aggregated ACK/NAK report (two divided by two), the mobile station **108** may transmit its aggregated ACK/NAK report in the second offset position or ACK/NAK channel, and the aggregated ACK/NAK report will occupy one ACK/NAK channel. The mobile station **110** may compute that because it will receive one data burst and will aggregate one ACK or NAK for one data burst in the aggregated

ACK/NAK report (one divided by two, rounded up), the mobile station **110** may transmit its aggregated ACK/NAK report in the third offset position or ACK/NAK channel, and the aggregated ACK/NAK report will occupy one ACK/NAK channel.

After or together with transmitting the transmission schedule **200** to the mobile stations **106**, **108**, **110**, the base station **104** may transmit a data burst **302** and a data burst **304** to the mobile station **106**. Upon receipt of these data bursts **302**, **304**, the mobile station **106** may determine whether each of the data bursts **302**, **304** was successfully received.

The base station **104** may also transmit a data burst **306** and a data burst **308** to the mobile station **108**. Upon receipt of these data bursts **306**, **308**, the mobile station **108** may determine whether each of the data bursts **306**, **308** was successfully received. The base station **104** may also transmit a data burst **310** to the mobile station **110**, and the mobile station **110** may determine whether the data burst **310** was successfully received.

According to an example embodiment, the mobile stations **106**, **108**, **110** may begin sending aggregated ACK/NAK reports to the base station **104** after the base station **104** has finished sending the data bursts **302**, **304**, **306**, **308**, **310**. The aggregated ACK/NAK reports may each indicate whether each of the plurality of data bursts **302**, **304**, **306**, **308**, **310** was successfully received by the respective mobile station **106**, **108**, **110**.

For example, the mobile station **106** may send an aggregated ACK/NAK report **312** in the first offset position or ACK/NAK channel indicating whether the mobile station **106** successfully received each of the data bursts **302**, **304**. The mobile station **108** may send an aggregated ACK/NAK report **314** in the second offset position or ACK/NAK channel indicating whether the mobile station **108** successfully received each of the data bursts **306**, **308**. The mobile station **110** may send an aggregated ACK/NAK report **316** in the third offset position or ACK/NAK channel indicating whether the mobile station **110** successfully received the data burst **310**. The base station **104** may receive each of the aggregated ACK/NAK reports **312**, **314**, **316**. Each of the aggregated ACK/NAK reports **312**, **314**, **316** may be sent via its own channel, such as an UL channel, according to an example embodiment. The base station **104** may determine whether to retransmit any of the data bursts **302**, **304**, **306**, **308**, **310** based on the aggregated ACK/NAK reports **312**, **314**, **316**.

FIG. **4** is a flowchart showing a method **400** according to an example embodiment. According to this example, the method **400** may include determining, at a base station **104** in a wireless network **102**, an uplink channel quality for a mobile station **106**, **108**, **110** (**402**). The determining (**402**) may include, for example, determining a distance of the mobile station **106**, **108**, **110** from the base station **104**. According to another example, the determining (**402**) may include determining a received signal strength of an uplink ACK/NAK channel for the mobile station **106**, **108**, **110**.

The method **400** may also include sending an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator to the mobile station **106**, **108**, **110** based on the determining. According to one example, the ACK/NAK indicator may be included in a transmission schedule which includes a schedule of data bursts which will be sent to the mobile station **106**, **108**, **110**. According to another example, the ACK/NAK aggregation indicator may indicate a number of the plurality of data bursts to be acknowledged or negatively acknowledged by the mobile station **106**, **108**, **110** per the at least one aggregated ACK/NAK report.

The method **400** may also include sending a plurality of data bursts to the mobile station **106**, **108**, **110** (**406**). The method **400** may also include receiving at least one aggregated ACK/NAK report from the mobile station **106**, **108**, **110** (**408**). According to an example embodiment, the at least one aggregated ACK/NAK report may include a plurality of ACK/NAK reports corresponding to the plurality of data bursts, each of the plurality of ACK/NAK reports indicating whether each of at least two of the plurality of data bursts, to which the plurality of ACK/NAK reports correspond, was successfully received or not. According to another example embodiment, an aggregated ACK/NAK report may be received via a single channel. According to another example, the aggregated ACK/NAK may include a tile combination vector.

According to another example embodiment, receiving the at least one aggregated ACK/NAK report may include receiving a plurality of aggregated ACK/NAK reports. Each of the plurality of aggregated ACK/NAK reports may indicate whether a number of the plurality of data bursts was successfully received or not. The number may be based on the ACK/NAK aggregation indicator. In an example embodiment, the number may be at least two.

According to another example embodiment, the receiving the at least one aggregated ACK/NAK report may include receiving a plurality of ACK/NAK reports superimposed onto a single ACK/NAK report channel.

According to another example, uplink channel qualities may be determined for a plurality of mobile stations **106**, **108**, **110**. ACK/NAK aggregation indicators may indicate a number of ACK/NAKs which each of the plurality of mobile stations **106**, **108**, **110** should aggregate per an aggregated ACK/NAK channel report. At least one data burst may be sent to each of the plurality of mobile stations **106**, **108**, **110**. At least one aggregated ACK/NAK may be received from each of the plurality of mobile stations **106**, **108**, **110**.

According to another example, each of the plurality of data bursts may include a plurality of data blocks. Each of the plurality of data blocks may include a cyclic redundancy code (CRC). In this example, the at least one aggregated ACK/NAK report may include an ACK/NAK corresponding to each of the data blocks.

FIG. **5** is a flowchart showing a method **500** according to an example embodiment. According to this example, the method **500** may include receiving, from a base station **104** in a wireless network **102**, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator (**502**). The ACK/NAK aggregation indicator may, for example, be included in a transmission schedule **200** which includes a schedule of data bursts which will be sent by the base station **104**.

The method **500** may further include determining which of a plurality of data bursts were successfully received from the base station **104** (**504**). The method **500** may further include sending at least one aggregated ACK/NAK report to the base station **104** (**506**).

The method **500** may further include aggregating a number of ACK/NAKs into the at least one aggregated ACK/NAK report. The at least one aggregated ACK/NAK report may include the number of ACK/NAKs, which each may correspond to one of the plurality of data bursts and indicate whether its corresponding data burst was successfully received. The number may be based on the ACK/NAK aggregation indicator.

According to an example embodiment, an aggregated ACK/NAK report may be sent via a single channel. According to another example embodiment, the aggregated ACK/

NAK report may include a tile combination vector. According to another example embodiment, the at least one aggregated ACK/NAK report may indicate whether each of the plurality of data bursts, such as the data bursts that were aggregated, were successfully received. A number of the plurality of data bursts which the aggregated ACK/NAK report indicates were or were not successfully received may be at least two, and may be based on the ACK/NAK aggregation indicator. According to another example embodiment, the at least one aggregated ACK/NAK report may include a plurality of superimposed ACK/NAK reports each indicating whether one of the plurality of data bursts was successfully received.

According to another example embodiment, the method **500** may further comprise aggregating a number of ACK/NAKs into the at least one aggregated ACK/NAK report. In this example, each ACK/NAK may correspond to one of the plurality of data bursts. The number may be based on the ACK/NAK aggregation indicator. The aggregated ACK/NAK may include each of the number of ACK/NAKs.

FIG. **6** is a block diagram showing an apparatus **600** according to an example embodiment. The apparatus (e.g. base station **104** or mobile node **106**, **108**, **110**) may include, for example, a wireless transceiver **602** to transmit and receive signals, a controller **604** to control operation of the station and execute instructions or software, and a memory **606** to store data and/or instructions.

Controller **604** may be programmable and capable of executing software or other instructions stored in memory or on other computer media to perform the various tasks and functions described above, such as one or more of the tasks or methods described above.

In addition, a storage medium may be provided that includes stored instructions, when executed by a controller or processor that may result in the controller **604**, or other controller or processor, performing one or more of the functions or tasks described above.

Implementations of the various techniques described herein may be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. Implementations may implemented as a computer program product, i.e., a computer program tangibly embodied in an information carrier, e.g., in a machine-readable storage device, for execution by, or to control the operation of, data processing apparatus, e.g., a programmable processor, a computer, or multiple computers. A computer program, such as the computer program(s) described above, can be written in any form of programming language, including compiled or interpreted languages, and can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by a communication network.

Method steps may be performed by one or more programmable processors executing a computer program to perform functions by operating on input data and generating output. Method steps also may be performed by, and an apparatus may be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. Elements of a computer may include at least one processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer also may include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory may be supplemented by, or incorporated in special purpose logic circuitry.

To provide for interaction with a user, implementations may be implemented on a computer having a display device, e.g., a cathode ray tube (CRT) or liquid crystal display (LCD) monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

Implementations may be implemented in a computing system that includes a back-end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation, or any combination of such back-end, middleware, or front-end components. Components may be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (LAN) and a wide area network (WAN), e.g., the Internet.

While certain features of the described implementations have been illustrated as described herein, many modifications, substitutions, changes and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the embodiments of the invention.

What is claimed is:

1. A method performed by a base station in a wireless network, the method comprising:

sending, to a mobile station, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator and at least a plurality of separate data bursts, wherein the ACK/NAK aggregation indicator indicates to the mobile station a number of the plurality of separate data bursts to be acknowledged or negatively acknowledged by the mobile station per aggregated ACK/NAK, wherein the number is two or more; and

subsequent to sending at least the plurality of separate data bursts:

on a first condition, receiving one aggregated ACK/NAK from the mobile station, the one aggregated ACK/NAK indicating an acknowledgement or a negative acknowledgement of each data burst of the number of the plurality of separate data bursts; and

on a second condition, receiving one aggregated ACK/NAK from the mobile station per at least two separate data bursts of the number of the plurality of separate data bursts, the one aggregated ACK/NAK indicating

an acknowledgement or negative acknowledgement of the at least two separate data bursts.

2. The method of claim 1, wherein on the second condition the aggregated ACK/NAK does not indicate whether each individual data burst was successfully received.

3. The method of claim 1, wherein the receiving the at least one aggregated ACK/NAK comprises at least one of the following:

receiving the aggregated ACK/NAK via a single channel;

receiving a tile combination vector; and

receiving a plurality of ACK/NAKs superimposed onto a single ACK/NAK channel.

4. The method of claim 1, further comprising:

the sending the ACK/NAK aggregation indicator comprises sending an ACK/NAK aggregation indicator to each of a plurality of mobile stations, each ACK/NAK aggregation indicator indicating a number of ACK/NAKs which each of the plurality of mobile stations should aggregate in each aggregated ACK/NAK sent by the mobile station;

the sending the at least the plurality of separate data bursts comprises sending at least two separate data bursts to each of the plurality of mobile stations; and

the receiving comprises receiving at least one aggregated ACK/NAK from each of the plurality of mobile stations.

5. The method of claim 1, wherein:

each of the plurality of separate data bursts includes a plurality of data blocks, each of the plurality of data blocks including a cyclic redundancy code (CRC); and

the at least one aggregated ACK/NAK includes an ACK/NAK corresponding to each of the data blocks.

6. The method of claim 1, wherein the first condition and the second condition are based on a channel quality condition associated with the mobile station.

7. A method performed by a mobile station in a wireless network, the method comprising:

receiving, from a base station in the wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, wherein the ACK/NAK aggregation indicator indicates to the mobile station a number of a plurality of separate data bursts to be acknowledged or negatively acknowledged by the mobile station per aggregated ACK/NAK, wherein the number is two or more;

subsequent to the receiving the ACK/NAK aggregation indicator, determining whether each data burst of at least the number of the plurality of separate data bursts was successfully received from the base station; and

sending, to the base station, at least one aggregated ACK/NAK based at least on the determining of whether each of at least the number of the plurality of separate data bursts was successfully received from the base station, wherein the sending the at least one aggregated ACK/NAK includes:

on a first condition, sending one aggregated ACK/NAK to the base station based on the determining, the one aggregated ACK/NAK indicating whether each data burst of the number of the plurality of separate data bursts was successfully received; and

on a second condition, sending one aggregated ACK/NAK to the base station based on the determining per at least two separate data bursts of the number of the plurality of separate data bursts, wherein the one aggregated ACK/NAK indicates whether the at least two separate data bursts were successfully received.

8. The method of claim 7, wherein the sending comprises at least one of the following:

sending the at least one aggregated ACK/NAK to the base station via a single channel;

sending the at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK including a tile combination vector; and

sending the at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK indicating whether each of the number of the plurality of separate data bursts was successfully received.

9. The method of claim 7, wherein on the second condition the aggregated ACK/NAK does not indicate whether each individual data burst was successfully received.

10. The method of claim 7, wherein the first condition and the second condition are based on a channel quality condition associated with the mobile station.

11. A base station of a wireless network, the base station comprising:

at least one processor; and

at least one memory including computer program code;

the at least one memory and the computer program code configured to, with the at least one processor, cause the base station at least to:

send, to a mobile station, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator and at least a plurality of separate data bursts, wherein the ACK/NAK aggregation indicator indicates to the mobile station a number of the plurality of separate data bursts to be acknowledged or negatively acknowledged by the mobile station per aggregated ACK/NAK, wherein the number is two or more; and

subsequent to sending at least the plurality of separate data bursts:

on a first condition, receive one aggregated ACK/NAK from the mobile station, the one aggregated ACK/NAK indicating whether each data burst of the number of the plurality of separate data bursts was successfully received; and

on a second condition, receive one aggregated ACK/NAK from the mobile station per at least two separate data bursts of the number of the plurality of separate data bursts, wherein the one aggregated ACK/NAK indicates whether the at least two separate data bursts were successfully received.

12. The base station of claim 11, further configured to perform at least one of the following:

receive the aggregated ACK/NAK via a single channel;

receive a tile combination vector; and

receive a plurality of ACK/NAKs superimposed onto a single ACK/NAK channel.

13. The base station of claim 11 wherein the first condition and the second condition are based on a channel quality condition associated with the mobile station.

14. A mobile station of a wireless network, the mobile station comprising:

at least one processor; and

at least one memory including computer program code;

the at least one memory and the computer program code configured to, with the at least one processor, cause the mobile station at least to:

receive, from a base station in the wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, wherein the ACK/NAK aggregation indicator indicates to the mobile station a number of a plurality of separate data bursts to be acknowledged or negatively acknowledged by the mobile station per aggregated ACK/NAK, wherein the number is two or more;

subsequent to receiving the ACK/NAK aggregation indicator, determine whether each data burst of at least the number of the plurality of separate data bursts was successfully received from the base station; and

send, to the base station, at least one aggregated ACK/NAK based at least on the determination of whether each of at least the number of the plurality of separate data bursts was successfully received from the base station, wherein the computer program code configured to with the at least one processor, cause the mobile station to send the at least one aggregated ACK/NAK includes causing the mobile station to:

on a first condition, send one aggregated ACK/NAK to the base station based on the determination, the one aggregated ACK/NAK indicating whether each data burst of the number of the plurality of separate data bursts was successfully received; and

on a second condition, send one aggregated ACK/NAK to the base station based on the determination per at least two separate data bursts of the number of the plurality of separate data bursts, wherein the one aggregated ACK/NAK indicates whether the at least two separate data bursts were successfully received.

15. The mobile station of claim **14** further configured to perform at least one of the following:

send at least one aggregated ACK/NAK via a single channel;

send the at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK including a tile combination vector; and

send the at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK indicating whether each of the number of the plurality of separate data bursts was successfully received.

16. The mobile station of claim **14**, wherein the first condition and the second condition are based on a channel quality condition associated with the mobile station.

17. The mobile station of claim **14** further configured to perform at least one of the following:

send at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK indicating whether each of the number of the plurality of separate data bursts was successfully received, the number being at least two and being based on the ACK/NAK aggregation indicator; and

send the at least one aggregated ACK/NAK to the base station, the at least one aggregated ACK/NAK including a plurality of superimposed ACK/NAKs each indicating whether one of the number of the plurality of separate data bursts was successfully received.

18. A non-transitory computer readable storage medium comprising executable code stored thereon that, when executed by a processor, causes an apparatus to at least:

send, to a mobile station, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator and at least a plurality of separate data bursts, wherein the ACK/NAK aggregation indicator indicates to the mobile station a number of the plurality of separate data bursts to be acknowledged or negatively acknowledged by the mobile station per aggregated ACK/NAK, wherein the number is two or more; and

subsequent to sending at least the plurality of separate data bursts:

on a first condition, receive one aggregated ACK/NAK from the mobile station, the one aggregated ACK/NAK indicating whether each data burst of the number of the plurality of separate data bursts was successfully received; and

on a second condition, receive one aggregated ACK/NAK from the mobile station per at least two separate data bursts of the number of the plurality of separate data bursts, wherein the one aggregated ACK/NAK indicates whether the at least two separate data bursts were successfully received.

19. The non-transitory computer readable storage medium of claim **18**, wherein the first condition and the second condition are based on a channel quality condition associated with the mobile station.

20. A non-transitory computer readable storage medium comprising executable code stored thereon that, when executed by a processor, causes an apparatus to at least:

receive, from a base station in a wireless network, an acknowledgment/negative acknowledgment (ACK/NAK) aggregation indicator, wherein the ACK/NAK aggregation indicator indicates to the apparatus a number of a plurality of separate data bursts to be acknowledged or negatively acknowledged by the apparatus per aggregated ACK/NAK, wherein the number is two or more;

subsequent to receiving the ACK/NAK aggregation indicator, determine whether each data burst of at least the number of the plurality of separate data bursts was successfully received from the base station; and

send, to the base station, at least one aggregated ACK/NAK based at least on the determination of whether each of at least the number of the plurality of separate data bursts was successfully received from the base station, wherein the executable code configured to cause the apparatus to send the at least one aggregated ACK/NAK includes causing the apparatus to:

on a first condition, send one aggregated ACK/NAK to the base station based on the determination, the one aggregated ACK/NAK indicating whether each data burst of the number of the plurality of separate data bursts was successfully received; and

on a second condition, send one aggregated ACK/NAK to the base station based on the determination per at least two separate data bursts of the number of the plurality of separate data bursts, wherein the one aggregated ACK/NAK indicates whether the at least two separate data bursts were successfully received.

21. The non-transitory computer readable storage medium of claim **20**, wherein the first condition and the second condition are based on a channel quality condition associated with the apparatus.

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